nuisance arising from smoke from factory and other furnaces, but in the present movement it is evident that the importance of the domestic fireplace as a foe, if not the chief one, to the purity of the air of cities, has been generally recognised and has been the main object of attack.

It is not a little remarkable that, although elaborate experiments have been made from time to time with a view to ascertain the nature and composition of the gases generated in furnaces, but little attention has been devoted to the gases given off from stoves and grates. On the Committee of the recent Smoke Abatement Exhibition chemists were well represented, and this brief notice will mainly refer to the general chemical results that have been obtained.

The examination of the gases withdrawn from flues to which stoves and grates were attached, was intrusted to Prof. Chandler Roberts, who at first considered that the analysis of representative samples might best be made by the aid of the rapid methods of gas analysis arranged by Orsat. In view, however, of the peculiar conditions under which the tests had to be made, and bearing in mind that more than one hundred appliances were submitted for testing in the limited time during which the Exhibition was open, Prof. Roberts submitted a plan to the Committee which received its approval.

He points out in his report that the first researches on chimney gases are due to Péclet, who published some results of analysis in 1828, but Péclet's results and those of different experimenters who followed him were open to the objection that the samples submitted to analysis were only small fractions of the total gases in the flues, and as the samples were not taken with sufficient frequency they could not represent the mean composition of the gaseous mixture passing up the chimney. This grave defect was, however, remedied by Scheurer-Kestner in an elaborate research on the composition of the flue-gases of boiler furnaces, which will always be the basis of future experiments in this direction, and to which frequent allusion is made in the Report. The details of the method adopted are given in the Report itself; it will be sufficient to say here that the gases were withdrawn through a fine slit in a tube extending across the flue, an arrangement which rendered it possible to draw the gases uniformly from the entire diameter of the ascending current of gas in the flues. The effluent gases were withdrawn by aspiration through a tube loosely filled with asbestos to retain the solid particles of carbon and soot; they then passed through a U-tube filled with chloride of calcium to absorb water, and thence through three U-tubes filled with soda-lime to absorb carbonic anhydride; the gases were then led to a tube of porcelain filled with cupric oxide and heated to redness by means of a small furnace. The complete combustion of the remaining gases was thus effected, the carbonic oxide being burnt to carbonic anhydride, and the hydrocarbons and free hydrogen to aqueous vapour and carbonic anhydride; the water was retained in a U-tube filled with chloride of calcium, and the carbonic anhydride in two other soda-lime tubes; the residual gases (unconsumed oxygen and nitrogen) then passed to the aspirator, a chloride of calcium tube being interposed to prevent any moisture from the aspirator from penetrating the system of tubes.

It will be evident that this plan renders it possible to compare the relative proportion of the completely burnt products of combustion with those in which combustion has been imperfect. With regard to the proportion of carbon lost as soot, the evidence afforded by the results of the tests made at the Exhibition, although they do not unfortunately render it possible to give a clear and precise answer to the question, are sufficiently definite to show that the amount probably does not exceed 1 per cent. of the total carbon in the fuel, and is in many cases far less.

The coal used in testing the grates and stoves was either 'Wallsend,' which yielded 67·1 per cent. of coke, or Anthracite, giving 94 per cent. on distillation in a closed vessel.

With regard to the completeness of the combustion, the carbon present in the form of carbonic anhydride varied in relation to that present as carbonic oxide and as hydrocarbons, C_xH_y, within the limits of 1,000 to 4 and 1,000 to 375, but of the whole eighty-six tests in only three was the number indicating imperfect combustion below 10, and in only nine cases was it above 200, and six of these nine cases (three grates and three stoves) were worked purposely for "slow combustion."

The total amount of carbon present in the gases ascending the flue (either in the free state or combined with carbon) bore a relation to the hydrogen present which varied between the limits of 1,000 to 8 and 1,000 to 259, the latter probably being due to the fact that the grates and stoves were tested whilst the mortar in which they were set was still wet.

The mean of the results of the tests of the seventeen best grates shows that the loss of carbon in the form of carbonic anhydride and hydrocarbons is about 3·4 per cent. of the carbon in the fuel used (in the case both of Anthracite and Wallsend), the mean for the whole of the grates being about 9 per cent. of the total carbon.

The comparative imperfection of the combustion shown in some of the tests is hardly to be wondered at when it is remembered that the bituminous coal employed yielded on distillation no less than 32 per cent. of volatile matter, and that in the case of many of the appliances the cold fuel was simply charged on to the top of a mass of coal already in the state of incandescence.

Professor Roberts cautiously points out that all that has hitherto been done in this series of tests "merely renders it possible to select certain typical appliances which deserve more detailed examination." He appears, however, to have spared no pains to render this very laborious investigation as complete as the circumstances allowed, and the Chemical section of this Report is certainly one of the most important contributions ever made to our knowledge of the combustion of fuel.

E. FRANKLAND

NORTH AFRICAN ETHNOLOGY

Sahara und Sudan: Ergebnisse Sechsjähriger Reisen in Afrika. Von Dr. Gustav Nachtigal. Part II. (Berlin: 1881.)

NEARLY a decade has elapsed since Dr. Nachtigal's return to Europe after his travels in East Sahara and Central Sudan during the years 1869-74. Most of the geographical and ethnological results of his researches in that region have already appeared at various times in the memoirs of the *Gesellschaft für Erdkunde* and of other learned societies. But the issue of the monumental work embodying all the details in a permanent form is proceeding at a very slow rate. The first part, covering the years 1869-70, did not appear till 1879, and an interval of two years elapsed before the publication of this second instalment, which, although forming a bulky volume of 790 pages, gets no further than the first days of September, 1872. In the preface the delay is attributed mainly to the time occupied in the tedious process of sifting the ethnological and especially the linguistic materials brought home by the traveller. The help afforded by Rudolf Prietze in arranging these materials is handsomely acknowledged in the preface, where occasion is also taken to express regret for omitting to give the source of the familiar mailclad, mounted Bornu warrior borrowed in Part I. from Denham and Clapperton's work, attention to which oversight had been called in our review of that volume (see NATURE, vol. xxi. p. 198).

The three books forming the present volume embrace the trips made to Kanem and Borku north of, to Baghirmi south of, Lake Chad, and to the islands in the lake itself. Separate chapters of great permanent value are devoted to the main geographical features of these regions, and to the history and complex ethnical relations of their inhabitants. Here special attention is naturally claimed by the mysterious Tubu people of the East Sahara, and a serious attempt is made to explain their relations on the one hand to the Hamitic Tuariks (Berbers) of the West Sahara, on the other to the Negro races of Sudan.

The Tubu, that is, "people of Tu" or Tibesti,[1] are by Lepsius[2] with great probability identified with the Garamantes of Herodotus (iv. 183), whose capital was Garama (Edrisi's Germa) in Phazania (Fezzan). Ptolemy, who places the Garamantes in the same region, that is, in the Libyan Desert (Sahara) south of the Syrtis Major (Gulf of Sidra), already speaks doubtfully of their ethnical affinities, and seems disposed to affiliate them rather to the Ethiopian (Negro) stock.[3] Later on this position is disturbed by Leo Africanus, whose fifth great division of the Berbers are the Gumeri (Garamantes?), whom he elsewhere calls Bardæi (Bardoa). These Bardæi, whose name appears to survive in the *Bardai* oasis of Tibesti, are accordingly identified by Vater with the Tubu, and by him grouped with the Berbers.[4] Now comes Lepsius, who again removes the Tubu from the Libyan (Berber) connection, and with Ptolemy transfers them to the Negro group. He admits a strong modification of the original dark, and a corresponding assimilation to the Libyan, type. But this is attributed to their position along the great historical trade route across the Sahara between North Africa and the Chad basin, while their language is regarded as decisive proof of their Negro relationship.[5]

And thus this interesting, if somewhat troublesome, nomad race has continued throughout the historic period to occupy a dubious ethnological position between the surrounding Hamitic and Negro peoples. That Dr. Nachtigal should attempt to grapple with the problem was inevitable, and although his own inferences are vague and hesitating, he at all events supplies ample material for a satisfactory solution. As in so many other anthropological fields, the difficulty turns, so to say, mainly on the collision between ethnical and philological interests The present physical resemblance of the Tubu to their western neighbours, the Berber Tuariks, admits of no doubt, and this resemblance increases as we proceed from the Dasa, or southern, to the Teda,[1] or northern, division of the race. In fact there is here the same gradual transition between the Hamites of the Sahara and the Negroes of Sudan, which is found further west all along the borderlands from Bornu to the Atlantic, and which is conspicuous especially in the more or less mixed Sonrhay, Pul, Hausa, and Toucouleur nations of the Chad, Niger, and Senegal basins. To these correspond in Central Sudan the Negroid Kanuri, Kanembu, Baele, and Zoghawa peoples,[2] while the same complexity is presented in the Nilotic regions, where the Nuba family merges imperceptibly north and south in the Egyptians and Negroes of the White Nile.

But Lepsius (*op. cit.*) now holds that the two elements have become interpenetrated throughout the whole of the Sudan, which he consequently regards as an intermediate zone of transition between the intruding Hamites from Asia and the autochthonous Negroes, whose original domain is relegated to the southern half of the continent. In this scheme, which thus recognises in Africa only two fundamental racial and linguistic types, what place can be assigned to the Tubu? We have seen that Lepsius himself disposes of the question by regarding them as originally Negroes assimilated physically to the Berbers, while retaining their primitive Negro speech. If this view could be accepted, we should have an instance of the linguistic surviving the ethnical type, a theory in which anthropologists would in any case be slow to acquiesce. But Dr. Nachtigal's researches, while confirming Barth and Koelle's conclusions regarding the intimate relation of Tubu to Kanem and Kanuri, also show that this group is fundamentally distinct from the Bantu, that is, from the typical Negro linguistic stock of Lepsius. If it could be affiliated to the Hamitic family, there would be no further difficulty as to the ethnical position of Tubu. But Nachtigal also shows that it differs quite as radically from Hamitic as it does from Bantu. His inquiries have in fact resulted in the discovery of an independent and widespread linguistic family corresponding in the East Sahara and Central Sudan to the northern Hamitic and southern Bantu groups. The source, or at least the most archaic known form, of this family is the Teda, or northern Tubu, whose direct offshoots are the more highly developed Dasa, or southern Tubu, the Kanem north of Lake Chad, the Kanuri of Bornu, the Baele of Ennedi and Wanyanga, and the Zoghawa of North Dar-Fur. More distant members appear to be the Hausa, Fulu, and Sonrhay of

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[1] Cf. *Kanem-bu* = people of Kanem, where *bu* is the pl. of the personal postfix *ma*, answering to the personal prefix *m*, pl. *ba*, *wa*, cf the Bantu races, as in M'Ganda, Waganda; and to the *be* of *Ful-be* = "Pul people."

[2] *Nubische Grammatik*, *Einleitung*.

[3] Ὄντων δὲ καὶ αὐτῶν ἤδη μᾶλλον Αἰθιόπων, i. 8.

[4] "Mithridates II.," p. 45 of Berlin ed. 1812

[5] "Ursprünglich ein Negervolk," *op. cit.*, *Einleitung*, xlviii.

[1] In this word *Teda* we have apparently the root of the *Tedamensii*, a branch of the Garamantes placed by Ptolemy south of the Samamycii in Tripolitana. If my identification is correct, it gives us a fresh proof of the identity of the Garamantes with the Tubu.

[2] See my paper "On the Races and Tribes of the Chad Basin," NATURE, vol xv p. 550.

West Sudan, the Logon, Bagrimma (Baghirmi), and Mandara (Wandela) of the Shary basin, and the Maba of Wadai. But the actual relationship of these and other outlying branches to the main trunk can only be determined by future research. Meantime, Dr. Nachtigal rests satisfied with having demonstrated the existence of this widely-ramifying family and its radical difference both from the Hamitic and Bantu groups. "How far the relationship may extend will be made more and more evident by a further study of the Sudan languages, especially the Hausa, Masa, Bagrimma, Maba. For the present it is enough for me to have established the relations of the Tubu dialects to each other, and of both to the Kanuri and Baele" (p. 209).

But when he comes to the consequences of his premisses he speaks with singular hesitation, as if overweighted or hampered by the brilliant generalisations of Lepsius. The fact is, this theory of the three zones leaves no room in Africa for the great linguistic family which Nachtigal has nevertheless discovered there. But instead of boldly giving up the theory, he timidly suggests alternatives, in order somehow to reconcile it with the actual conditions. After clearly showing the independent position of Tubu, he leaves the reader to choose between a possible "extremely remote connection with the Negro languages, or, if it be preferred, to regard it as a distinct species, which has held its ground between the Negro and Hamitic linguistic types" (p. 201). Most ethnologists will probably be prepared to accept the latter alternative, even at the risk of adding one more to the two "linguistic types" which alone Lepsius will tolerate. The only point of contact between Tubu and Bantu seems to be the absence of grammatical gender, a negative feature which both share with a thousand other languages in the Old and New Worlds. Yet apparently in order to save Lepsius's scheme, Nachtigal is content on this weak ground to allow a connection between Teda and Negro, adding, still more inconsequently, "in which case, considering the vagueness of the concept 'Negro' (bei der Unbestimmtheit des Begriffes 'Negro'), there can certainly be no objection to group the Tubu themselves with the Negroes, although, taking the word in its ordinary sense, in other respects they essentially differ from them" (p. 209). So the Negro—that is, the most marked of all human varieties—is frittered away to a "vague concept," because Tubu is a no-gender language, or because Lepsius will allow only two linguistic types in Africa.

But by getting rid of this theory, an easier exploit than getting rid of the Negro, everything will fall into its place. The consideration that the centre of evolution of the Tubu group lies, not in Sudan, but in the Sahara, far north of the original Negro domain, placed by Lepsius south of the equator, would almost alone suffice to separate it from that connection. Dr. Nachtigal himself shows that Teda, or northern Tubu, represents the germ, of which the southern Dasa, Kanuri, Baele, &c., are later developments. He also shows that the migrations, as was natural to expect, were always from the arid plains and uplands of the Sahara to the fertile region of Sudan. Except under the lash of the slave-driver, the Blacks seem never to have moved northwards. But we have seen that the roving nomads, Tuariks in the west, Tubu in the east, have everywhere, all along the line, penetrated from their desert homes into the "Black Zone." The inference seems obvious. Nachtigal himself regards the Tubu as "a thoroughly pure, homogeneous people (*eine durchaus reine, homogene Bevölkerung*), unmodified by any changes from remote times" (p. 190). He also shows their close physical resemblance to the Tuariks (Berbers) of the western Sahara, and their essential difference from the Negro type. The anthropologist will not hesitate to remove them from the latter and group them with the former race. The Tubu and Berbers are thus ethnically two slightly differentiated branches of the Hamitic section of the great Mediterranean (Caucasic) division of mankind.

From this standpoint the Tubu speech, although as radically distinct from the Hamitic as it is from the Bantu, will no longer present any difficulty. In Europe the Mediterannean races have developed at least one radical form of speech, the Basque; in Asia several, the Aryan, Semitic, Georgian, and others in Caucasia. Why should they not have developed two in Africa, the Hamitic and Tubu? Elsewhere I have endeavoured to account for this remarkable phenomenon of specific diversity of speech within the same ethnical group.[1] Here it will suffice to note the fact, and if the no-gender character of Tubu be urged as a difficulty, the reply is twofold. First, no-gender languages occur also in other Caucasic groups, as in Basque, Georgian, Lesghian; secondly, although gender has not been developed in Tubu, nevertheless it contains the raw material, so to say, which has been elaborated into a system by the more cultured Hamitic peoples. After admitting that, but for the absence of this feature, there would be no scruple (*Bedenken*) in affiliating Tubu to the Hamitic order, Dr. Nachtigal adds: "Tubu also certainly seems to possess the elements by which gender is indicated in the Hamitic—*o* and *p* for the masculine, *t* for the feminine, as in *o-mri*, man; *mi*, son, by the side of *âdi*, woman; *dô*, daughter; *dê*, mother; *edi*, female" (p. 200). Here *d* of course answers to *t*, the universal mark of the feminine gender in Hamitic, and in the Berber group often both prefixed and postfixed, as in *akli*, negro; *taklit*, negress.

Room must therefore be made in Lepsius's scheme for a third linguistic family, the honour of having determined which belongs to Dr. Nachtigal. This Tubu family must be assumed to have been independently evolved in remote ages by the Garamantes, ancestors of the Tubu nomads, during long isolation in Kafara, Kawár, Tibesti, and the other oases of the eastern Sahara and Fezzan. Lastly, the Tubu themselves must be absolutely separated from the Negro ethnical connection, and grouped with the Hamites in the Mediterranean division of mankind.

A. H. KEANE

OUR BOOK SHELF

The Electric Lighting Act, 1882, *the Acts incorporated therewith, the Board of Trade Rules, together with numerous Notes and Cases.* By Clement Higgins, M.A., Recorder of Birkenhead, and E. W. W. Edwards, B.A., Barrister-at Law. (London: W. Clowes and Sons, 1883.)

PRACTICAL electricians unversed in law, and lawyers unversed in the practical applications of electricity, will

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[1] See Appendix to my "Asia" (Stanford Series), p. 695.